unit II nano physics:- Synthesis of nanostructure materials.

(i) Write a short note on (i) Bottom up method. (02)
(ii) Top-down method.
(iii) Photolithography.

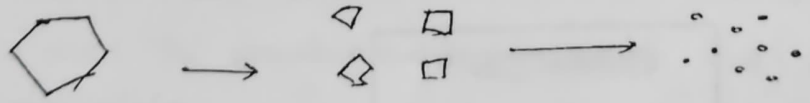
Bottom up:-

(i) one of the general aproach for synthesis of nanomaterial is Bottom up approach. Bottom up approach involves building of nanoparticles from individual atom or molecule. This approach allows for precise control over the size shape and composition of nanoparticles and is commonly used in nanotechnology and material science.
ex- Sol-gel synthesis, chemical vapor deposition. etc.

(ii) Top down:-

In the top down approach, large bulk materials are broke-down into smaller nanoparticles through various mechanical, chemical, or physical methods. This method is used for making desire shape of nanoscale mg. nanomaterials from bulk particle.

Ex- Lithography, etching, mechanical grinding.



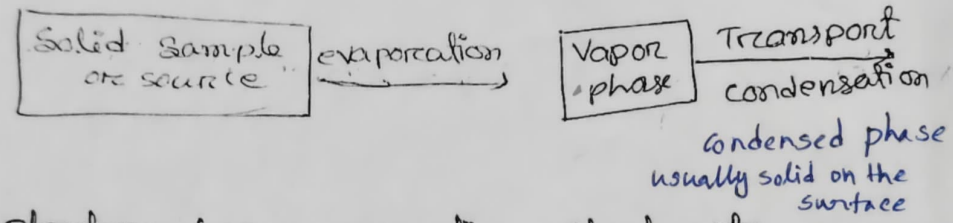
(iii) • Photolithography:-

Photolithography is the most used top down method in microfabrication to pattern a substance. In this process a geometrical pattern from a template is transferred to the silicon wafer. Silicon wafers used as stones and patterns are written with light sensitive polymer called

photoresist.

Q. Short note on physical vapour deposition.

⇒ Physical vapor deposition is a deposition process by which source material is vaporized from a solid or liquid source in the form of atoms or molecules, and then transported in the form of a ~~vapor~~ vapor. through a vacuum or low pressure gaseous environment to the substrate where it condenses.



Q electron beam evaporation, short note.

⇒ Electron beam evaporation is a physical vapour deposition technique that uses a beam of high-energy electrons to heat and evaporate a material to create a thin coating on a substrate.

we can easily evaporate high temperature metals in this process.

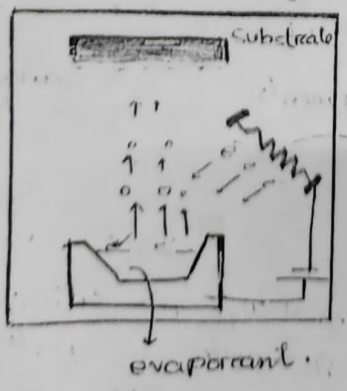


fig - e⁻ vapour deposition beam

• Short note on thermal evaporation:-

Thermal evaporation is the simplest physical vapor deposition. In this method the solid material is evaporated by using resistive heating and the atoms are then deposited on the substrate through a condensation mechanism.

The evaporation source is a tungsten filament that ~~can be~~ heated by passing a high current

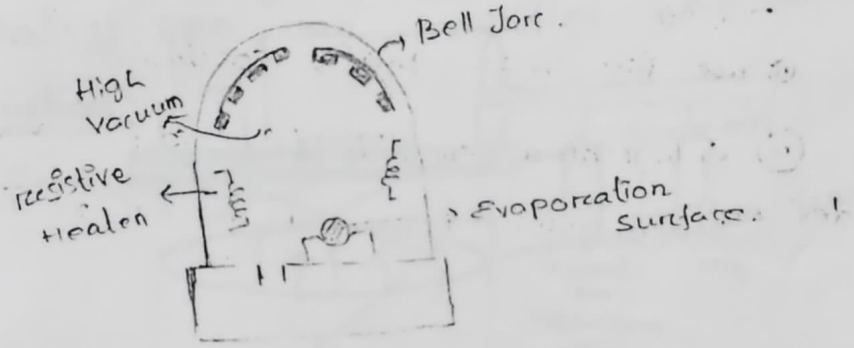


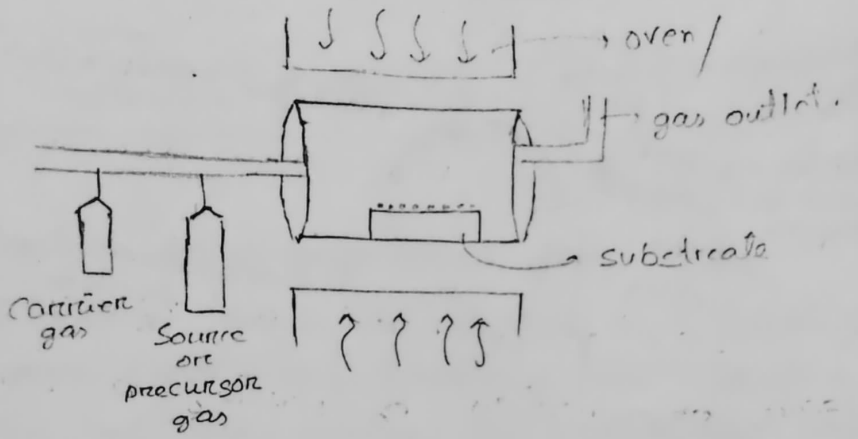
fig :- Schematic Diagram of Thermal evaporation.

• Short note on chemical vapour deposition.

⇒ Physical Chemical vapour deposition is a ~~deposition processes~~ bottom up approach for the synthesis of nano structured ~~mat~~ material. It is a chemical process that is used to produce high quality, high performance solid materials.

In this process source gas or precursor gas is forced by carrier gas into the chamber. The chamber is heated to a reaction temperature that causes the precursor gas to ~~react~~ breakdown, and then able to react. This reaction take place in between precursor molecule and substrate molecule which is present on surface of substrate. As a

result a coating of nanomaterial is formed in the surface of substrate.



Use (i) It is suitable for large area thin film coating.

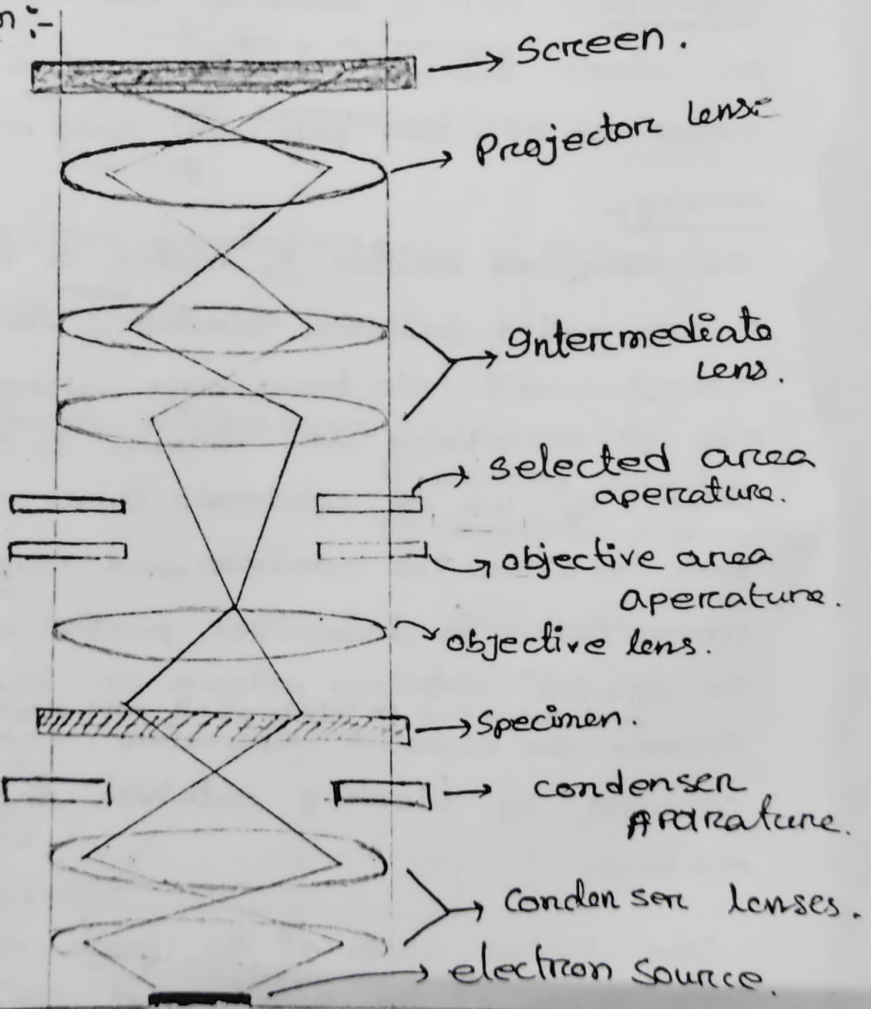
(ii) use for high quality coating.

(iii) Integrated circuits (ICs), photovoltaic device, etc are produced by CVD method.

Q. Transmission e⁻ microscope. (i) construction.
(ii) principle & working.
(iii) advantage & disadvantage.

⇒ TEM is used to find the internal structure of materials. It can magnification upto 300 thousand times. Latest TEM can magnifies upto 50 million time.

• Construction :-



⇒ TEM is made up of an electron gun, that emits a beam of monochromatic electrons as the illumination source. A set of condenser lenses to focus the illumination onto specimen. then an objective lens is used to form first image of the specimen. Selected area aperature and objective area aperature are used to form narrow beam and focusing. and a series of magnifying lenses are use to create the final magnifying image on the screen which include projector lense and intermediate lens.

Principle:- TEM is based on the mass thickness or atomic thickness consept. ~~the~~ atomic thickness means no of atom per unit area or volume.

working:-

Electrons are emitted by heating a filament. This e⁻ are called primary electron beam. The stream of monochrometic electrons move along the optical axis of microscope and focused to a thin coherent beam by use of condenser lenses. The beam then strikes the specimen and parts of it are transmitted. This transmitted portion is focused by the objective lens and produce an image on the screen. The objective aperature and magnified by intermediate and projector lenses. enhance the contrast by blocking out high angle diffracted electrons.

The darker areas of the image represent those areas of the sample that fewer electrons are transmitted means high atomic density. And the lighter areas of the image represent those areas of the sample that more electrons

were transmitted means lower atomic density.

That's how we can analise the internal atomic structure of any sample.

• Advantage:

(i) It can create magnification of 1 million time or more.

(ii) It has wide range of application in educational, scientific and industrial field.

(iii) TEM can provide information on element & compound structure.

(iv) Easy to operate..

Drawback:

① It is large and very expensive.

② TEM is very time consuming and required special training.

③ Sample may be damage by e^- beam.

④ only 2D image is possible.

5. Atomic force microscope ① construction.
② working principle
③ advantage disadvantage.

construction:-

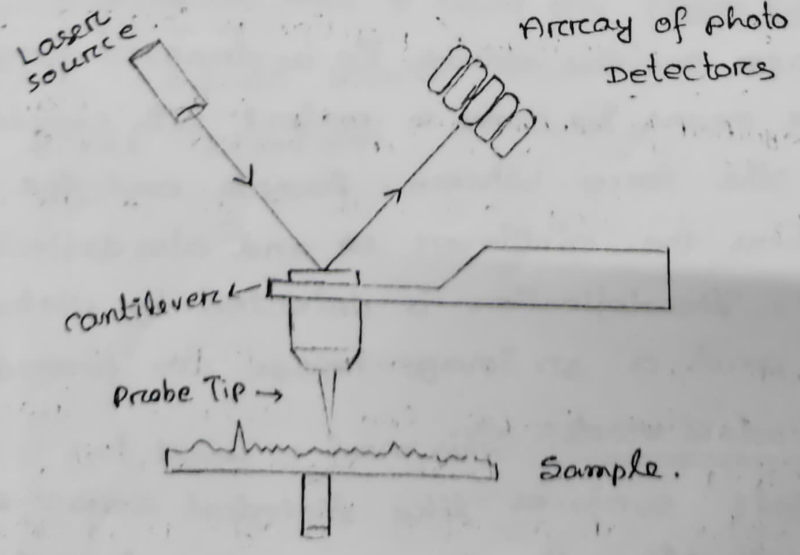


fig:- Atomic force microscope.

• The main component of AFM is cantilever having a sharp tip at the end. The tip is in the size of nanometer and it is made of silicon. A source of Laser light is placed for creation a sharp laser beam. Lastly Array of photo detectors is placed to detect the Laser beam which is reflected from the top of the cantilever, photodiode convert the laser light into electric current and this current furture transfer into a computer to produce a 3D Sample image.

• ~~working~~ :-

• Principle :- AFM works on the principle that a fine sharp tip of the order of nanometer ~~attracted to a cantilever when~~ when bring closer to a sample surface, the vander walls forces between tip & sample produces a deflection of the cantilever according to Hooke's law. the deflection is measured by laser ~~spot~~ reflected from the top of cantilever into photodetector.

• Working :- AFM works on 2 modes.

(i) contact mode :- This mode is used for imaging solid surfaces. In this method tip is dragged across the sample means tip comes in contact with sample surface. The force between sample and the tip desplaces the cantilever ~~of~~ and also deflection of laser. This deflection is detected by photo detectors and a 3D image image was formed.

(ii) non-contact mode :- This mod is used for imaging soft surfaces like biological surface, DNA, human cell etc. In this mode tip does not

make any contact with sample surface. The tip is kept at a constant height of few nm above the sample surface Vanderwall forces between tip and sample surface will deflect the cantilever and this deflection is detected by photodiode and a proper 3-D image was formed.

- advantage:-

① It can produce 3-D image.
② It does not require vacuum.
③ It has high resolution power.
④ It can image non-conducting surface like glass, plastic, polyman etc.

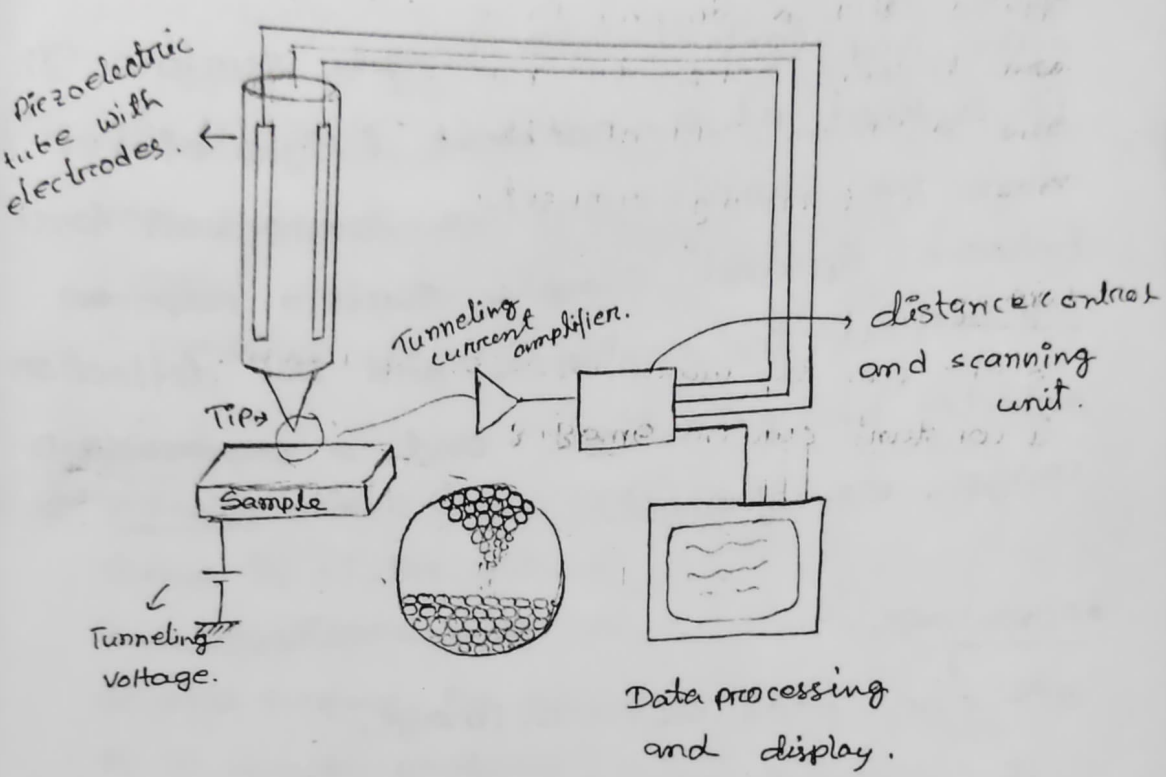
- disadvantage:-

① In contact mode breaking of tip is a great problem.

Q

⇒ Scanning tunneling microscope (i) (ii) (iii).

⇒ Construction:-



~~• STM is~~

The main component of STM is a sharp tip made up of tungsten metal. At the end of the tip their is only one atom of material. Tip is attached to a piezoelectric tube scanner. [By adjusting voltage of piezoelectric tube the distance btn tip and sample can regulated]. A tunneling voltage device is connected to the sample for creating tunneling current. An amplifier is used to ~~amplify~~ amplify the tunneling current. This amplified current is passes in scanning unit where a strong computer analysis the data and then a 3-D picture created on the display screen.

Principle:- STM is based on the principle of Quantum mechanics electron tunneling effect. ie when 2 flat metal surfaces seperated by a small distance and a voltage difference between the surfaces are applied, then a driving force acts on the electron to move across the barrier by tunnelling and a small current flows. This current is known as tunneling current.

Working:-

There are two main modes of operation.

① Constant current imaging:-